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UDC 621.9.048,7:621.762:669,14.018.252.3

Structure and Properties of High-Speed-Tool Powder Steels After Laser Treatment

18420234c Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 4, Apr 88 pp 48-50

[Article by I. L. Yavtseva, Moscow Highway Institute]

[Abstract] An experimental study of two high-speed-tool powder steels, R-OMo2V3-MP (1.19 percent C, 4.29 percent Cr, 3.36 percent V, 2.94 percent Mo) and 10R-6Mo5-MP (1.05 percent C, 5.50 percent Mo, 4.10 percent Cr, 1.95 percent V) containing not more than 0.02 percent S, P, and O₂ each, was made for a determination of the effect of laser treatment on their structure and mechanical properties. Specimens of both were heated with a laser beam to temperatures ranging from below to above the melting point and were then quenched from the austenitic state and from the liquid state respectively. Subsequent measurements revealed a hardening effect on R-OMo2V3-MP steel as well as on both "bright" and "dark" components of 10R-6Mo5-MP steel with a microhardness within the fusion zone, however, lower than after optimum conventional volume heat treatment. These results, confirmed by metallographical examination and x-ray phase analysis, indicate that laser treatment improves the mechanical properties of the two steels, but only if done without melting. References 4: all Russian.

2415/9835

Crystal Structure and Low-Temperature Breakup of Carbonaceous Martensite
Produced by Hardening Laser Treatment

18420234d Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 4, Apr 88 pp 50-53

[Article by Yu. V. Kalner, Moscow Steel and Alloys Institute]

[Abstract] An experimental study was made concerning the feasibility of diffusion-less true martensite transformation of steels with retention of the original carbon content in the solid solution as a result of hardening laser treatment. Square bars $25 \times 25 \text{ mm}^2$ in cross-section and 70 mm long of St20 and St40 plain carbon steels, U8 straight-carbon tool steel, and 25CrMnNiMoTi alloy steel were first refined by heat treatment and then, covered with a heat-absorbent MnPO_4 coating, treated with a laser beam without melting. This treatment was done in a SPECTRA PHYSICS facility with a 2 kW laser beam 7 mm in diameter moving along the bars at velocities of 3-7.5 cm/s. Subsequent macrostructural examination was done under a "NEOPHOT-21" optical microscope after etching, microhardness was measured in a PMT-3 tester with a 1 N load, and the crystal structure was examined in a DRON-3 x-ray diffractometer with a FeK_{α} -radiation source. The results reveal inhibition of two-phase breakup of martensite in St40 and U8 steels upon tempering at a temperature of 100C for 1-2 h after laser treatment with $(6-12) \cdot 10^7 \text{ J/m}^2$ energy density, St20 low-carbon steel and 25CrMnNiMoTi steel with higher martensite transformation temperature requiring laser treatment with lower energy density of about $5 \cdot 10^7 \text{ J/m}^2$ for achievement of such a transformation not possible by conventional heat treatment in a furnace. The study was done under the guidance of M. L. Bernshteyn. References 1: Russian.

2415/9835

Structure of Sintered High-Mn Powder Alloys and Characteristics of Their Fracture

18420234a Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 4, Apr 88 pp 18-20

[Article by T. F. Volynova and I. Z. Yemelyanova, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] An experimental study of sintered Fe-base powder alloys containing 9-40 percent Mn was made, this range of Mn content covering formation of all three (b.c.c., c.p.h., f.c.c.) crystal lattices. Carbonyl Fe and

electrolytic Fe powders were used as base material, for a comparative evaluation, Mn powder obtained by comminution of Mn sponge being added in specific amounts. Metallographical examination was done under a "Neofot" optical microscope; hardness and microhardness were measured in a TK-2M tester and in a PMT-3 tester respectively; phase analysis was done in a DRON-1.5 x-ray diffractometer with a FeK_{α} -radiation source. Fractographical examination and surface microanalysis were done under a JSM-T300 scanning electron microscope with a "Link" x-ray microanalyzer. The results indicate that sintered alloys based on carbonyl Fe are chemically and structurally much more homogeneous than those based on electrolytic Fe. The porosity level and the mode of fracture were found to depend on the Mn content, owing to different diffusion rates. The porosity was found to increase with increasing Mn content and to cease obeying the laws of mechanics of continuous media upon reaching a critical level, this level being approximately 15 percent Mn in the case of carbonyl Fe and below 9 percent in the case of electrolytic Fe as base material. Secondary large pores form along isolated primary small ones above that critical level, the Kirkendall effect operating here, with many more pores appearing and chains of pores eventually forming as the Mn content approaches 40 percent. The results of structural and surface examination reveal both ductile and brittle modes of intercrystalline or trans-crystalline fracture. References 7: 6 Russian, 1 Western.

2415/9835

UDC 669.187.2.054

Effect of Energy Losses on Temperature of Liquid Metal in Focal Spot of Heat-Treating Electron Beam

18420236d Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 88 (manuscript received 4 Sep 86) pp 63-65

[Article by Yu. V. Korniyushin and S. V. Ladokhin, Kiev]

[Abstract] Heating of liquid metal with a fast scanning electron beam is analyzed for the effect of energy losses, the temperature of liquid metal in the focal spot being calculated on the basis of energy balance which includes heat absorbed by the metal for evaporation and heat radiated by the metal into ambient space. The first of three terms on the right-hand side of the equation with the laser power on the left-hand side represents heat conducted through the metal away from the spot, proportional to the temperature difference between metal in the spot and metal surface outside the spot as well as to three-halves power of the spot diameter and to one-half power of the scan velocity. The second term represents heat radiated from the spot, proportional to fourth power of the spot temperature and to the spot diameter squared. The third term represents heat of evaporation, inversely proportional to one-half power of the spot temperature and proportional to the temperature-dependent saturated-vapor pressure as well as

to the spot diameter squared. Numerical estimates have been made on the basis of this relation for Ti, Fe, Ni, Zr, Nb with the power density in the focal spot 13 MW/m², 200 MW/m², 320 MW/m², 13 MW/m², 100 MW/m² respectively. The results indicate that loss on evaporation is dominant. References 7: 6 Russian, 1 Western (in Russian translation).

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UDC 669.71'871'85/86

Effect of Gallium on Surface Activity of Rare-Earth Metals in Aluminum Alloys

18420236c Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 88 (manuscript received 6 Jun 86) pp 52-53

[Article by A. L. Sukhman, V. I. Kononenko, and V. V. Torokin, Sverdlovsk]

[Abstract] An experimental study of binary Al-alloys with rare-earth metals, weakly surface-active ones (La,Ce) and strongly surface-active ones (Sm,Eu,Yb), was made for the purpose of determining the change in their surface activity upon addition of Ga. For comparison, Ga was also added to binary Al alloys with the not surface-active Sc and Y. All alloys were produced from AV-000 aluminum and grade M-1 La,Ce,Sm,Eu,Yb,Sc and Y, with the content of each rare earth metal varied over the 0.5-3 atom.percent range, whereupon 1 atom.percent Ga-000 gallium was always added. Each alloying metal and the Ga had been three times remelted under vacuum for refinement. Surface tension of the alloys in the liquid state was measured at temperatures ranging from the melting point of aluminum to 1173 K. The results reveal that Ga stimulates the surface activity of all rare-earth metals, but not additively, as indicated by the decrease of surface tension with increasing concentration of rare-earth metal. This effect of Ga is attributable to formation of atomic groups such as Al₂R compounds at the surface. The more appreciable increase of surface activity of the intrinsically most surface-active rare-earth metals (Sm,Eu,Yb) is attributable to their anomalously high electronegativity. References 7: 5 Russian, 2 Western (in Russian translation).

2415/9835

Electrical Transport of Zn and Cd in Liquid Gallium and of Sb and Bi in Liquid Indium

18420236b Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 88 (manuscript received 19 Sep 86) pp 48-51

[Article by M. V. Korniyevich, V. A. Mikhaylov, L. I. Shchukin and V. A. Sergeyeva, Kemerovo]

[Abstract] The electrical mobility of Zn and Cd in molten Ga at a temperature of 50 C and of Sb and Bi in molten In at temperatures of 270 C and 350 C was measured over the transient period of settling in vertical quartz capillaries 1.5 mm in diameter thermostatically controlled with air cooling, at a current density of 475 A/cm² in Ga with either impurity and 1620 A/cm² or 970 A/cm² in In with either impurity, GL-000 gallium having been doped with 10⁻³ wt.percent Zn or Cd and IN-00 indium having been doped with 10⁻² wt.percent Sb or with 10⁻³ wt.percent Bi. The wall thickness of the capillaries was nominally 2 mm, varying within the 1.95-2.05 mm limits, and their inside diameter did not taper more than 0.03 mm from one end to the other. The redistribution of Zn or Cd in Ga and of Sb or Bi in In along the capillary was monitored colorimetrically with use of appropriate organic indicators, their initial and final steady-state concentrations being logarithmic functions of the vertical coordinate. Analysis of the data and calculation of the cross-section for electron scattering by the impurities in accordance with the Einstein relation, taking into account molecular diffusion, have yielded higher values for Cd, Sb, Bi and a lower value for Zn than have calculations based on the electrical conductivity of the respective pure metals. References 20: 15 Russian, 1 Yugoslav, 4 Western (2 in Russian translation).

2415/9835

UDC 669.295:621.785.73

Phase Transitions in Two-Phase Titanium Alloys During Mechanical Testing at Various Temperatures

18420220a Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 3, Mar 88 pp 31-36

[Article by M. A. Dyakova and Ye. A. Lvova, Urals Polytechnical Institute]

[Abstract] Two-phase titanium alloys VT33 and VT23 were annealed at 760 C for 4 hours, cooled with the furnace, hardened in water from 760-900 C and subjected to mechanical testing at normal temperature and at -196 to +400 C after holding at each temperature for 15 minutes. The phase composition was studied by x-ray structural analysis of specimens cut from the head and fracture point of standard tensile test specimens. It was found that mechanical properties depended on the heating temperature of hardening, tensile strength increasing with increasing hardening temperature, yield point showing a valley on the curve. Formation of deformation α'' martensite was observed in hardened alloys with metastable beta phase upon tensile testing. After hardening from the critical temperature (820 and 860 C for VT33 and VT23, respectively), the yield point is minimal due to the presence of the α'' martensite. Decomposition of the metastable beta phase at elevated temperatures hardens the alloys. References 10: all Russian.

6508/9835

Influence of Hydraulic Pressing on Hardening of VT22 Alloy

18420220b Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 3, Mar 88 pp 36-39

[Article by A. A. Adamets, T. Ye. Konstantinova, Yu. I. Yurkovskiy and
V. V. Shikunov]

[Abstract] A study is made of the influence of initial composition of the two-phase titanium alloy VT22 (5.4% Al, 4.7% Mo, 5.0% V, 1.0% Cr, 0.93% Fe, 0.13% C, 0.13% O, 0.06% S) on deformation hardening. The variation in mechanical properties as a function of the degree of deformation and aging conditions was determined. Three modes of heat treatment were used, producing structures of three types, differing significantly in quantity and morphology of the phases. The alloy hardened from the beta area had the maximum quantity of beta phase, with large-grain structure. Slow cooling from temperatures corresponding to the beta area produced a coarse-plate (alpha + beta) structure containing 25-30% residual beta phase. Isothermic annealing by heating to 850 C, holding 1.5 hours, cooling with the furnace to 750 C, holding three hours, and cooling in air produced an (alpha + beta) structure transition between plates and globules, containing 60-70% beta phase. The degree of hardening during hydraulic extrusion was found to depend on the phase and structural state of the alloy before deformation, with more hardening in the two-phase state with transitional structure than in the single-phase or large-plate structure. The dispersed two-phase structure is therefore best for achievement of the greatest strength. References 10: all Russian.

6508/9835

Influence of Microalloying on Elastic Properties of VT14 Titanium Alloy

18420220c Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 3, Mar 88 pp 39-40

[Article by Yu. K. Kovneristyy, V. P. Kuznetsov, S. G. Fedotov, V. V. Sheredin
and Yu. N. Shulgina]

[Abstract] A study is made of the influence of microalloying with small quantities of boron, hafnium and rhenium on the elastic properties and fatigue resistance of high strength VT14 titanium alloy. The alloys were made in a vacuum arc furnace by double remelting and the ingots rolled to a thickness of 0.3 mm with intermediate annealing and etching. All alloys were heat treated by annealing at 750 C for 2 hours in a vacuum, hardening from 870 C in water following heating in vacuum-sealed quartz ampules, aging at 480 C for 8 hours in an electric furnace in air. Microalloying with

0.005-0.05% rhenium was found to increase the elastic limit by 10-20% and relaxation resistance by a factor of two. Residual deformation increased very slightly. Microalloying with 0.01-0.03% hafnium increased the elastic limit by 10%, while greater quantities reduced it to the original level. Hafnium decreased fatigue strength. References 6: 5 Russian, 1 Western.

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UDC 620.17:669.715'5'721

Properties of Casting Alloys in the Al-Zn-Mg System

18420220d Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 3, Mar 88 pp 44-46

[Article by P. N. Nikitin, N. I. Blinov, T. A. Pastukhova and A. Yu. Nartov]

[Abstract] A study was made of the structure, mechanical and anticorrosion properties, as well as the nature of microplastic local deformation, of aluminum alloys in the Al-Zn-Mg system corresponding to the Zn:Mg=1.7 cross section on the constitution diagram passing through the two-phase (α +T) area in the cast state and after various modes of heat treatment. The maximum strength was achieved after hardening and artificial aging. Aging increased strength by 42-160N/mm². Microplastic deformation was found to occur nonuniformly. After artificial aging or hardening and artificial aging, intercrystalline crack propagation occurred. Fracture of specimens in the hardened state was mixed. The alloys showed no tendency toward general or intercrystalline corrosion. References 7: all Russian.

6508/9835

UDC 669.28'781-158

Structure of Rapidly Cooled Alloys in the Mo-B System

18420220e Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 3, Mar 88 pp 47-50

[Article by Ye. N. Ageyeva, M. M. Kantor, S. B. Maslennikov and I. V. Korkin, Metallurgy Institute imeni A. A. Baykov, USSR Academy of Sciences; Physical Technical Institute, USSR Academy of Sciences]

[Abstract] A study is made of the influence of the content of boron on the formation of the structure in cast binary alloys of molybdenum with boron. Studies were performed on ingots with a mass of 25g obtained by melting in the suspended state, yielding great homogeneity of the alloys, solid solutions of which are unstable even when cooled very rapidly. Melting was performed

in 20-30 seconds in a sealed chamber with an atmosphere of purified helium, after which specimens were cooled at 400K/s in a massive copper mold into which the specimens were dropped by disconnecting the electromagnetic field. The degree of decomposition of the solid solution upon cooling was estimated by diffraction electron microscopy using specimens prepared by electrolytic jet polishing in an electrolyte consisting of 95ml H₂SO₄ and fml CH₃OH. A minimum was found in the curve of grain size as a function of boron content at 0.002%B. The true solubility of boron cannot be determined by traditional methods; the limiting concentration of boron which can be fixed in the internal volumes of molybdenum grains was determined in these experiments as 0.008%B. References 15: 9 Russian, 6 Western.

6508/9835

UDC 669.28.286

Mechanical Properties of Mo-Re Alloys at Various Test Temperatures

18420220f Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 3, Mar 88 pp 50-53

[Article by A. V. Abramyan, N. N. Morgunova, S. A. Golovanenko and N. I. Kazakova, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin; Armstanok Scientific-Production Association]

[Abstract] This article, continuing previous studies, investigates the mechanical properties of Mo-Re alloys in the deformed and recrystallized states over a broad range of rhenium contents using ingots 80mm in diameter obtained by vacuum-arc remelting with rhenium content varying from 0.2 to 36%. The ingots were forged and rolled into 8 and 12mm bars. The temperature at which recrystallization began was determined by the appearance of the first recrystallization grains in the microstructure. The mechanical properties were determined at normal temperature in the deformed and recrystallized states and at temperatures of 1000, 1400 and 1800 C in the deformed state. As the rhenium content increased from 7 to 36% in recrystallized alloys, the strength and ductility increased as normal temperatures. In the deformed states increasing short-term strength did not correlate to increasing ductility. With 4-6% Re in the recrystallized state there was a sharp increase in ductility. Small quantities (0.2-0.5%) of rhenium had the best influence on strength at high temperatures, apparently as a result of the increased recrystallization temperature. The increase in strength with increasing rhenium content up to 36% is smaller the higher the test temperature. At 1800 C the strength of alloys containing 4 to 36% Re is no greater than that of alloys with 0.2-0.5% Re. References 4: 3 Russian, 1 Western.

6508/9835

Use of TiNi Alloys With Shape-Memory Effect in Technology and in Medicine

18420234b Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 88 pp 45-48

[Article by B. P. Khasenov, A. A. Kadnikov and D. I. Rabkin]

[Abstract] Since thermoelastic martensite transformation was discovered in 1949 by G. V. Kurdyumov and L. G. Khandros, an Au-Cd alloy having then been found in 1951 by L. C. Chang and T. A. Read to have shape memory, over 50 alloys, TiNi among them, are now used in technology and in medicine. Applications for TiNi in technology include pipe joints, heat engines, compensation along overhead electric power transmission lines, protection against solar radiation, and manufacturing aids such as winding premolders. Areas of application for TiNi in medicine include traumatology, orthopedics, facial-maxillary surgery, vascular surgery requiring filters and clot traps, dynamic spine clamping, and x-ray endovascular prosthetics. The suitability of TiNi alloys for these applications is based on their fast heating and cooling as well as long life under cyclic loads. References 22: 13 Russian, 9 Western (3 in Russian translation).

2415/9835

Effect of Oxygen on Magnetic Susceptibility of Nickel at High Temperatures

18420236a Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 88 (manuscript received 21 Nov 86) pp 41-47

[Article by V. S. Gushchin, B. P. Goltyakov, D. B. Shulgin and B. A. Baum, Sverdlovsk]

[Abstract] An experimental study of nickel was made for the purpose of determining the effect of oxygen inclusion on its magnetic susceptibility at high temperatures up to above the melting point. Specimens of N-0 electrolytic Ni were first melted in an inert atmosphere at 1460 C and then cooled to 300 C, their average between initial and final O₂ content being 0.004 percent; some specimens were remelted with an electron beam so that their average O₂ content dropped to 0.0014 percent and some specimens were first pulverized in air before being remelted in an inert atmosphere so that their average O₂ content rose to 0.015 percent. All other impurities were controlled (0.002 percent Co, 0.001 percent Fe, 0.001 percent Cu, 0.0008 percent N, less than 0.0008 percent Mn, less than 0.0006 percent Si, less than 0.0005 percent As, 0.0003 percent Cd, 0.0003 percent H) so as to ensure approximately the same content of each over the entire lot of specimens, with a variance not exceeding 6 percent. All specimens were cooled to 300 C before being heated to 1000 C and then in 8-15 C steps to 1800 C,

with a 2-3 min holding period at each temperature in a He atmosphere for measurement of the magnetic susceptibility by the Faraday method and plotting its temperature dependence. The results reveal that Ni with a higher O_2 content has a much lower magnetic susceptibility over the entire temperature range and that above the Curie point nickel in liquid state as well as in solid state obeys the Curie-Weiss law in terms of the overall trend of its magnetic susceptibility. The anomalous peaks of the latter at 1150 C as well as within the 1455-1460 C melting-crystallization range are explained by spin density fluctuations in a micrononhomogeneous material. References 10: 8 Russian, 2 Western (1 in Russian translation).

2415/9835

UDC 538.245

Effect of Carbon on Magnetic and Thermal Properties of Invars

18420236e Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 88 (manuscript received 9 Oct 86) pp 115-117

[Article by V. M. Kalinin, Sverdlovsk]

[Abstract] An experimental study of Invars (Fe-Ni alloys with f.c.c. crystal lattice) containing 27-50 atom.percent Ni was made for the purpose of determining the effect of carbon inclusion on their saturation magnetization and Curie point. All specimens were annealed at a temperature of 1000 C under a vacuum of 10^{-4} mm Hg and then quenched in water into a disordered state. Specimens of each alloy were split into two groups, 0.96 atom.percent C being added to those of the first group and 2.76 atom.percent C being added to those of the second group. The results of measurements reveal that the saturation magnetization of each alloy increases slightly with increasing carbon content and the Curie point rises linearly with increasing carbon content. This effect of carbon is found to be strongest in low-Ni alloys, in which mixed exchange interaction occurs, and weaken with higher Ni content. The results are interpreted in terms of thermodynamic theory with the Curie point a function of alloy volume and impurity concentration, which yields a dependence of the intensity of ion-exchange interaction on the change of interatomic distance with changing pressure. References 9: 7 Russian, 2 Western.

2415/9835

Dependence of Formation of Solid Solutions in Al-Si System on Cooling Rate

18420236f Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 88 (manuscript received 27 Oct 86) pp 192-196

[Article by A. M. Nesterenko, K. I. Uzlov, V. A. Kutsova, A. N. Nishchenko and M. G. Kovalchuk, Dnepropetrovsk]

[Abstract] An experimental study of alpha and beta solid-solutions in the binary Al-Si system was made for the purpose of determining the dependence of their composition on the cooling rate. Hypoeutectic alloys with 6.0-10.2 wt. percent Si and hypereutectic alloys with 11.56-40.56 wt. percent Si were cast, some specimens of each into wedges in a heavy mold with the cooling rate varied over the 10^2 - 10^3 K/s range and some specimens of each into thin ribbons on the surface of a fast rotating drum (3000 rpm) while being cooled at a rate of 10^5 K/s. Phase analysis in a DRON-3M x-ray diffractometer with a CuK_{α} -radiation source and a filter, A999 aluminum and chemically pure silicon annealed in an inert atmosphere serving as reference standards, was followed by calculation of the lattice parameters. Microstructural examination was done under a microscope with x800 magnification, after deep etching with concentrated HF plus CrO_3 or with saturated aqueous NaOH solution, and microhardness measurements were made for identification. The results indicate that the solubility of Si in Al-based alpha solid-solutions, hypoeutectic and hypereutectic, increases as the cooling rate is raised. Cooling the hypereutectic alloys at rates from 10^2 K/s up was found to yield two Si-based solid-solutions, a beta-1 with nearly equilibrium lattice period and a beta-2 highly supersaturated. The concentration of the latter increased but its lattice period remained the same as the cooling rate was raised. References 14: 11 Russian, 3 Western (2 in Russian translation).

2415/9835

UDC 537.311.13

Formation and Collapse of Thermodonors-II in Silicon Crystals With High Carbon Content

18420221a Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88
(manuscript received 8 Apr 86) pp 193-197

[Article by V. M. Babich, N. P. Baran, Yu. P. Dotsenko, K. I. Zotov,
V. B. Kovalchuk and M. Ya. Skolobkhod, Semiconductor Institute, Ukrainian
Academy of Sciences]

[Abstract] A study is presented of the formation, collapse and properties of thermodonors-II in oxygen-containing Si crystals with high carbon content, using the Hall effect, EPR, x-ray diffraction studies and selective chemical etching. Following long-term heating to 920K, the crystals manifested a broad spectrum of donor centers with thermal ionization energies of 0.014 to 0.2 eV, similar to the continuous donor trap spectrum at the Si-SiO₂ interface. Resistance to high temperatures varies with thermal ionization energy, the shallowest centers with energies of 0.014 to 0.019 eV being most stable, collapsing only at 1370K, while deeper centers with thermal ionization energy of about 0.2 eV collapse at 1170K. The processes of formation and collapse of donor centers are found to accompany processes of formation and collapse of acceptor-type centers. References 10: 1 Russian, 9 Western (1 in Russian translation).

6508/9835

Heat Treatment of Germanium Doped With Copper and Oxygen

18420221b Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88
(manuscript received 4 Apr 86) pp 198-201

[Article by Ye. V. Skudnova, V. F. Degtyarev and V. K. Prokofyeva,
Metallurgy Institute imeni A. A. Baykov, USSR Academy of Sciences]

[Abstract] Results are presented from a study of the thermal stability of defects with local E_v levels of +0.013 eV. Their nature and possible structure are discussed. Studies are performed on n-type germanium with $6 \cdot 10^{13} \text{ cm}^{-3}$ antimony and $4 \cdot 10^{16} \text{ cm}^{-3}$ oxygen. Copper was added to the specimens during diffusion annealing at 1120K, its concentration reaching $5.8 \cdot 10^{15} \text{ cm}^{-3}$. The major method of investigation was measurement of the Hall effect at 7-300K. The concentration of centers with levels of +0.013 eV was found to depend on annealing temperature. The centers have good thermal stability up to 1070K. References 11: 7 Russian, 4 Western (1 in Russian translation).

6508/9835

Influence of Ion Doping and Heat Treatment on Structural Properties of Epitaxial GaAs Layers

18420221c Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88
(manuscript received 15 Apr 86) pp 202-206

[Article by I. N. Sorokin, N. A. Klebanova, N. N. Avramenko, G. N. Terentyeva,
S. V. Nosikov, A. V. Chernyav'ev and A. S. Rodina, Moscow Electronic
Engineering Institute]

[Abstract] A search was made for electrically active accumulation-type defects in ion-doped films by means of selective chemical etching to study the influence of heat treatment on the generation and collapse of these defects in the implanted and epitaxial layers of gallium arsenide. The specimens used were epitaxial films with n-type conductivity 2.5-2.8 microns thick with charge carrier concentration $8 \cdot 10^{15}$ - $2 \cdot 10^{16} \text{ cm}^{-3}$. These were grown by gas-phase epitaxy on strongly tellurium-doped substrates. The layers of gallium arsenide were doped with zinc ions in an ion-beam accelerator, zinc ion energy 40 keV, dose $1.3 \cdot 10^{16}$ and $1.9 \cdot 10^{16} \text{ ions/cm}^2$. The ion bombardment increased the density of defects in the epitaxial layer at the depth of the p-n junction, reaching 10^7 cm^{-2} in all specimens. Annealing at 200 C for 72 hours decreased the density of impurity accumulations and increased the concentration of charge carriers. In epitaxial layers, the density was decreased only by an annealing temperature of 700 C. A correlation of defect density with basic charge carrier mobility at 650 C indicated

that the defects were accumulations of point defects formed due to gettering of impurity ions on vacancy clusters. References 7: 6 Russian, 1 Western (in Russian translation).

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UDC 621.315.592.002:546.55

Growth and Properties of $\text{InP-Ga}_x\text{In}_{1-x}\text{As}_y\text{P}_{1-y}$ Heterostructures

18420221d Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88 (manuscript received 8 Apr 86) pp 207-210

[Article by L. S. Lunin, V. I. Ratushnyy, T. A. Askaryan and V. N. Gaponenko, Novocherkassk Polytechnical Institute imeni S. Ordzhonikidze]

[Abstract] Epitaxial layers were grown in the Ga-In-As-P system by zone recrystallization with a temperature gradient on an indium phosphide substrate oriented in the (100) plane. Sandwiches of $\text{InP-(Ga+In+As+P)-InP(Ga}_x\text{-In}_{1-x}\text{As}_y\text{P}_{1-y})$ with a liquid zone 50 to 1300 microns thick were produced and subjected to zone recrystallization with a temperature gradient in a chamber evacuated to $133.3 \cdot 10^{-5}$ Pa and then filled with hydrogen to 200-300 kPa. Experimental and theoretical data on distribution of components in the $\text{Ga}_x\text{In}_{1-x}\text{As}_y\text{P}_{1-y}$ layers obtained by zone recrystallization with temperature gradient agreed satisfactorily, confirming the ability to use the distribution coefficients of the components determined by measurement in layers of $\text{Ga}_x\text{In}_{1-x}\text{As}_y\text{P}_{1-y}$ of constant composition in future computations. The dislocation density in the layers was found to depend primarily on composition, zone thickness and temperature of zone recrystallization. References 8: 6 Russian, 2 Western.

6508/9835

UDC 539.32

Influence of Chromium on Elastic Properties of Lead Telluride

18420221e Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88 (manuscript received 27 Mar 86) pp 227-229

[Article by A. N. Vasilyev, Yu. P. Gaydukov, V. P. Zlomanov, V. N. Nikiforov and O. I. Tananayeva, Moscow State University imeni M. V. Lomonosov]

[Abstract] The elastic properties of PbTe and $\text{Pb}_{0.991}\text{Cr}_{0.009}\text{Te}$ single crystals are studied for the first time in the 4-150 K temperature interval. The single crystals were synthesized by the vapor-liquid-crystal method from

a charge consisting of 95 mol.% PbTe+5 mole.% CrTe. The introduction of chromium to the lead telluride was found to increase the elasticity modulus C_{11} by a factor of 1.4 and C_{44} by a factor of 2.7 in the studies of longitudinal and transverse ultrasonic wave velocity as a function of temperature. References 9: 6 Russian, 3 Western.

6508/9835

UDC 541.123.7

Reactions in the Systems $\text{LaB}_6\text{-M}^{\text{IV-VI}}\text{B}_2$

18420221f Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88 (manuscript received 15 Apr 86) pp 235-238

[Article by S. S. Ordanyan, Leningrad Technological Institute imeni Lensovet]

[Abstract] Lanthanum hexaboride is promising for the creation of thermo-emission materials with low work function, resistance to ion bombardment, high electron density, durability and stability. This article studies the structure and thermodynamic properties of $\text{LaB}_6\text{-M}^{\text{IV-VI}}\text{B}_2$ materials ($\text{M}=\text{Ti, Zr, Hf, V, Nb, Ta, Cr}$), presenting the basic characteristics of the materials in tabular form and a constitution diagram of the system. Almost all of the f-elements form stable hexaborides with the structure of CaB_6 and high melting point. It is predicted that their interactions with $\text{M}^{\text{IV-VI}}\text{B}_2$ and characteristics will be similar to those found for the systems $\text{LaB}_6\text{-M}^{\text{IV-VI}}\text{B}_2$. References 17: 16 Russian, 1 Western.

6508/9835

UDC 669.017--35'788+620.193.5

Behavior of Copper-Phosphorus System Alloys in a Hydrogen Medium

18420221g Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88 (manuscript received 28 Feb 86) pp 243-246

[Article by G. F. Kobzenko, N. S. Kobzenko, V. B. Chernogorenko and A. A. Shkola, Metal Physics Institute, Ukrainian Academy of Sciences; Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] A study is made of the influence of hydrogen on the structure and microhardness of copper casting alloys containing up to 14 mass % phosphorus, as well as some commercial copper-phosphorus solders. Alloys were obtained by ampule synthesis from high purity materials in finely cut and powder form in quartz ampules evacuated to 0.13Pa for one hour before sealing. The mixtures were heated to 425K for 48 hours, then heated 870K and held for 72 hours,

after which the reacted mixture was heated to 1275K and, after melting, slowly cooled to room temperature. Disk specimens were cut, degreased, treated in a vacuum of 1.3Pa at 400K for 2.5 hours, placed in a reactor, which was evacuated to 0.1Pa at room temperature, after which hydrogen was introduced. The alloys were studied by gravimetry, metallographic and durometric analysis following hydrogen treatment in two modes: at 20 MPa at room temperature for 10 days; at 775K and 10 MPa for two hours, followed by rapid cooling to room temperature. No changes were observed at 20 MPa at room temperature, but specimens heated to 775K at 10 MPa did absorb hydrogen and lose phosphorus, form volatile compounds and change their properties. References 10: 8 Russian, 2 Western (1 in Russian translation).

6508/9835

UDC 541.45

Properties of Lanthanum-Strontium Cobaltites $\text{La}_{1-x}\text{Sr}_x\text{CoO}_{3-\delta}$ as Gas Discharge Device Cathode Materials

18420221h Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88 (manuscript received 10 Apr 85) pp 294-298

[Article by A. N. Petrov, N. I. Lipatov, D. N. Zybin, L. Ya. Rabinovich and O. F. Kononchuk, Urals State University imeni A. M. Gorkiy; General Physics Institute, USSR Academy of Sciences]

[Abstract] A study is presented of the conductivity and electric emission properties as well as the oxygen nonstoichiometry of lanthanum-strontium cobaltite $\text{La}_{0.7}\text{Sr}_{0.3}\text{CoO}_{3-\delta}$. The composition was selected because it has been reported to have the optimal catalytic activity and conductivity. Lanthanum-strontium cobaltite is found to have the unique combination of properties required for gas discharge device cathode materials. References 16: 6 Russian, 10 Western.

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UDC 541.133:537.311.3

Superion Conductor $\text{RbCu}_4\text{Br}_3\text{I}_2$ and Its Solid Solutions

18420221i Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88 (manuscript received 27 Sep 83) pp 299-302

[Article by V. V. Ivanov, V. F. Vybornov, A. M. Kolomojets and V. S. Shvetsov, Novochoerkassk Polytechnical Institute imeni Sergo Ordzhonikidze]

[Abstract] A study is made of interactions in the system RbI-CuI-CuBr using specimens synthesized from preliminary purified salts by melting in evacuated

ampules at 570K with holding for 1 hour. The melted mixture was then ground, pressed into tablets and heated to 495-513K for 7 hours, after which grinding and heating were repeated. X-ray studies were performed. Conductivity specimens were pressed in a quartz ring with inside diameter 3.2-3.3 mm, specimen thickness about 4mm. The compound $\text{RbCu}_4\text{Br}_3\text{I}_2$ was found to have superior conductivity at above 423K. The boundaries of isostructural solid solutions produced by partial replacement of iodine with bromine were established. References 7: 3 Russian, 4 Western.

6508/9835

Temperature Change in Relative Brittleness of Ceramic

18420221j Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 2, Feb 88 (manuscript received 15 Jan 86) pp 315-318

[Article by G. A. Gogotsi, Institute of Strength Problems, Ukrainian Academy of Sciences]

[Abstract] Previous studies by the same author have classified ceramics and other materials with little deformation under load on the basis of specifics of their mechanical behavior and shown that there are two basic classes of such materials: Brittle and relatively brittle materials. This article continues the study of the mechanical behavior of ceramics at high temperatures. As temperature increases, brittle ceramics usually show decreased elasticity modulus, an increase or decrease in maximum deformation and strength, but constant or decreasing brittleness measure. In relatively brittle ceramics and refractories, as temperature rises the strength and maximum deformation increase, but the brittleness measure may first increase, then remain approximately constant, then finally decrease. This behavior probably results from the fact that at lower temperatures the brittleness measure is related to structural damage upon deformation, while at higher temperatures it is related to softening of the vitreous phases and appearance of microplasticity. Figures 2; references 13: 10 Russian, 3 Western.

6508/9835

Tetragonotrioctahedron {511}: Simple New Crystalline Form of Synthetic Diamond

18420235a Kiev SVERKHTVERDIYYE MATERIALY in Russian No 2, Mar-Apr 88
(manuscript received 29 Jul 87) pp 3-7

[Article by N. V. Novikov, A. S. Vishnevskiy and V. N. Kvasnitsa, Superhard Materials Institute and Geochemistry and Mineral Physics Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] A new crystalline form of synthetic diamond, namely a tetragonotri-octahedron {511}, has been discovered during study of green-yellow specimens of a cubic habit distorted into having tetragonotrioctahedron as well as octahedron and rhombododecahedron faces. Crystals of this simple new form were synthesized separately by the conventional method of spontaneous crystallization, with a Ni-Mn alloy serving as solvent, at a temperature of 1100-1200 C under a pressure of 4.5-5.0 GPa. Companion crystals of other forms were produced alongside, owing to nonequilibrium of the crystallization process. Evidently, the process can be eventually controlled so as to yield synthetic diamond crystals of any desirable simple form. References 19: 15 Russian, 4 Western (1 in Russian translation).

2415/9835

UDC 666.233

Formation of Multilayer Polytypes Based on Diamond or Sphaleritic Boron Nitride Under High Pressures at High Temperatures

18420235b Kiev SVERKHTVERDIYYE MATERIALY in Russian No 2, Mar-Apr 88
(manuscript received 22 Jan 87) pp 7-9

[Article by V. F. Britun, G. S. Oleynik and A. N. Pilyankevich, Institute of Material Science Problems, UkSSR Academy of Sciences, Kiev]

[Abstract] Cubic phases of C, BN^{sphalerite}, SiC^{sphalerite} were examined under an electron microscope, for a study of transformations, possibly into hexagonal phases, resulting in the formation of a one-dimensionally disordered intermediate state and then multilayer polytypes under pressures and at temperatures yielding compact polycrystalline specimens. This study revealed an appreciable plastic deformation of diamond and BN^{sphalerite} during heating under a pressure of 80-100 kbars, groups of packing defects and especially of microtwins indicating an ordered subsequent relaxation process. References 7: 5 Russian, 2 Western (1 in Russian translation).

2415/9835

Temperature Dependence of Young's Modulus and of Internal Friction in Compact Modifications of Boron Nitride

18420235c Kiev SVERKHTVERDYIE MATERIALY in Russian No 2, Mar-Apr 88
(manuscript received 4 Feb 86) pp 9-13

[Article by V. E. Shipilo, N. A. Shishonok and A. V. Mazovko, Solid State and Semiconductor Physics Institute, BSSR Academy of Sciences, Minsk]

[Abstract] An experimental study of commercially pure polycrystalline $\text{BN}_{\text{sphalerite}}$ obtained by direct transformation of $\text{BN}_{\text{hexagonal}}$ as well as of its Hexanite-R, Elbor-RM and Belbor modifications was made, for the purpose of determining the dependence of their Young's modulus E and internal friction Q^{-1} under a load alternating at kilohertz frequencies on the annealing temperature. Measurements were made by the composite-beam method, most suitable for low-frequency tests, with specimens rigidly mounted in holders. The specimens, $1.5 \times 2 \times 4 \text{ mm}^3$ large right parallelepipeds, had metallographically polished faces. The data, evaluated taking into account relaxation processes and adjusted for the thermomechanical behavior of the holder material, reveal a strong temperature dependence of both Young's modulus and internal friction: the former decreasing continuously as the annealing temperature is raised and the latter beginning to increase as the annealing temperature exceeds 830-850 K. Below that temperature range Young's modulus becomes higher after more load cycles, within that temperature range it ceases to depend on the number of load cycles, and above that range it continues to decrease at a regularly increasing rate. These trends correspond to restructurization of the defectiveness pattern. Successively higher peaking of internal friction above that critical temperature range is most likely caused by presence of impurity-vacancy complexes and their reorientation in the field of alternating mechanical stresses. Lengthy annealing may cause breakup of these complexes and thus eliminate the peaks. References 6: all Russian.

2415/9835

Change in Electrical Conductivity of Diamond Powder During Graphitization of Its Surface

18420235e Kiev SVERKHTVERDYIE MATERIALY in Russian No 2, Mar-Apr 88
(manuscript received 9 Jan 87) pp 32-34

[Article by D. V. Fedoseyev, G. A. Sokolina, V. L. Bukhovets, S. V. Bantsekov, B. A. Anikin and O. I. Lazareva, Physical Chemistry Institute, USSR Academy of Sciences, Moscow]

[Abstract] An experimental study concerning graphitization of diamond powder was made for the purpose of determining the dependence of its electrical

conductivity on the amount of graphite building up on the surface. Specimens of natural diamond powder with a dominant 0.007-0.010 mm grain size fraction were graphitized by heat treatment at temperatures ranging from 1773 K to 1873 K for appropriate lengths of time ensuring only surface graphitization. The amount of graphite, namely the mean thickness of the graphite layer, was measured by the method of selective etching in a cold glow-discharge air plasma. The electrical conductivity was measured over the 293-1000 K temperature range under a pressure of 13.3322 mPa, 0.5 carat of diamond powder being placed in a cell and a V7-30 10^{-13} - 10^{-8} A electrometer or a Shch-302 multirange instrument reading the current. An evaluation of the results, with diamond powder treated as a polycrystalline substance and with two values of the activation energy serving as indicator of change, reveals that the electrical conductivity increases and its temperature dependence becomes weaker with increasing thickness of the graphite surface layer. This effect saturates and the electrical conductivity becomes independent of the temperature as the graphite layer thickness reaches 160 nm, such very small amounts of graphite thus evidently determining the electrical properties of diamond powder. References 10: 9 Russian, 1 Western.

2415/9835

UDC 679.8.022

Diamond Treatment of Soft Crystalline Materials

18420235f Kiev SVERKHTVERDYIE MATERIALY in Russian No 2, Mar-Apr 88
(manuscript received 9 Sep 86) pp 46-48

[Article by L. L. Burman and V. V. Rogov, Superhard Materials Institute, UtkSSR Academy of Sciences, Kiev, E. A. Pavlov, Novosibirsk Instrument Making Plant, and S. N. Dub, Kiev]

[Abstract] An experimental study concerning diamond treatment of nine optical-grade soft crystalline materials was made, treatment being grinding with a diamond tool. Specimens of Si(111), Ge(111), LiNbO_3 , CaF_2 (111), LiF (001), BaF_2 (111), ZnSe, CdSb, and MgAl_2O_4 were ground with ATb-10x3 preformed diamond wheels (3-50 percent ASN 10/7-40/28 micropowder or 50 percent AS2, AS6, AS15, AS20 125/100 micropowder in M3-17 metal binder) for 15-20 s at a speed of 560 rpm under a pressure of 0.1-0.3 MPa, with 3 percent aqueous solution of glycerin serving as lubricant-coolant fluid. For comparison, specimens of these materials were also ground with diamond wheels containing 5-25 percent ASN 20/14 micropowder in M3-17 metal binder. The data on Vickers hardness and Evans-Charles fracture toughness of these materials after grinding have been processed on the basis of a semiempirical expression relating the productivity of grinding these materials to the productivity of identically grinding K8 optical glass. The results indicate that grinding these materials with diamond wheels can be as efficient as grinding them conventionally with an abrasive stream of free diamond grains. References 5: 4 Russian, 1 Western.

2415/9835

UDC 62-987

Dependence of Service Life of Toroidal Hard-Alloy Dies on Method of Hardening

18420235d Kiev SVERKHTVERDYIE MATERIALY in Russian No 2, Mar-Apr 88
(manuscript received 8 Apr 87) pp 21-24

[Article by V. P. Bondarenko, V. K. Gerasimenko, M. G. Loshak, K. I. Sirota, A. F. Lisovskiy and L. I. Aleksandrova, Superhard Materials Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] A comparative study involving four batches of toroidal dies made of the W-Co6 hard alloy for high-pressure apparatus was made for the purpose of determining the dependence of their service life on the method of sintering and the mode of supplementary treatment. All four batches were produced from the same mix of ingredients, with a high degree of homogeneity and a small variance of physical properties within each batch. The nominal coercive force and flexural strength were: 1) 8.8 kA/m and 1840 MPa, 2) 9.4 kA/m and 1820 MPa, 3) 10.0 kA/m and 1970 MPa, 4) 10.8 kA/m and 1790 MPa. The coercive force correlated with the average size of WC grains and the volume fraction of largest WC grains as well as with the volume fraction of graphite inclusions and also with the average size of pores and the volume fraction of largest pores. Each batch of dies, all having identical toroidal parts, was split into three groups: one for immediate heat treatment and one for additional impregnation with Co melt before heat treatment, the third being left in the initial state as a control group. Tests involving hardness measurement as well as magnetic measurements before and after fracture have revealed that impregnation with Co melt increases the durability of such high-pressure apparatus. References 5: all Russian.

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